Synthesis and the electrolyte of the functional polystyren-based latex

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Occurrence of electrode reactions requires formation of an electric double layer at the electrode surface.

Although a distribution of ions in a double layer can be calculated from the Gouy-Chapman equation, it has not been able to prove the validity. It is desirable to see the formation and the structure of diffuse double layers. Visibly sized ionic particle, ionic latex particles, are expected to allow us to visualize the formation and the structure of the double layer. Our aim is to see the motion of visible large molecules by use of the latex which has strongly acid substitution, styrene sulfonate. The latex is predicted to work for supporting electrolyte and formation of the charge double layer at the electrode.

The latex, polystyrene-polystyrene sulfonate, was synthesized from polymerization of the styrene and then copolymerization of styrene sulfonate, according to the previous method[1]. Styrene was purified by distillation. Poly(*N*-vinylpyrrolidone)(PVP) was used as a stabilizer or surfactant during the dispersion polymerization of styrene.α-azoisobutyronitrile(AIBN), 2-propanol, and the PVP were used as received. PVP was dissolved in 2-propanol in a three-necked round-bottomed flask. The mixture maintained to 70 °C under the nitrogen atmosphere for 12h. A solution of styrene containing AIBN was added drop-wise, and then methanol and sodium styrene sulfonate were added drop-wise to vigorously stirred PVP/2-propanol solution for 24h. The solution became a milky white suspension. The suspension had optically visible particles (Fig.1) which polymerized was dispersed uniformity in water.

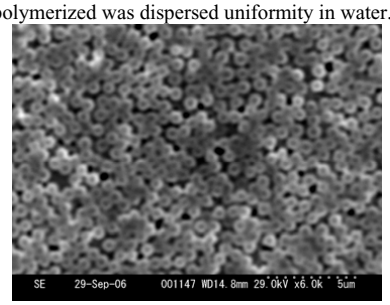

Fig.1.SEM Photograph of polystyrene-polystyrene sulfonate.

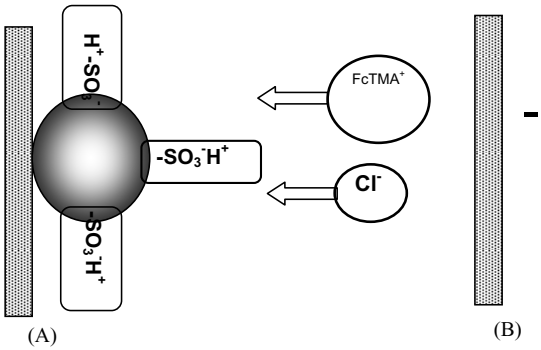

Fig.4.Illustration of ion transfer in solution for (A) without and (B) with salt. (A) contains sulfonate latex.

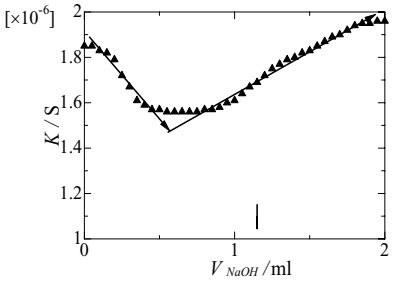

Fig.2. Variation of conductance of the latex suspension when NaOH solution was titrated.

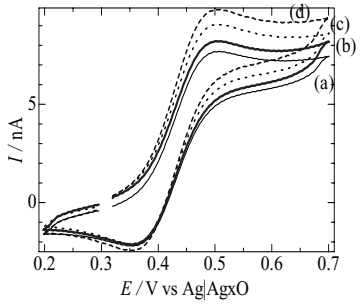

Fig.3. Cyclic voltammograms of FcTMA-including polystyrene sulfonate suspensions for (a) FcTMA 1mM, (b) with latex0.004 mM, (c) 1.32 with latex0.01 mM, (d) with latex 0.02 mM.

Concentration of sulfonate per particle evaluated by conductometric titration (Fig.2) was 6.5 mM, suggesting a strong acid. Cyclic voltammetry was made in the latex suspension including (ferrocenylmethyl) trimethylammonium chloride (FcTMA) and sodium ferrococenylsulfonate (Fig.3). The anodic current peak increased as concentration of the latex was higher. The increase can be explained in terms of electric migration, as follows. $FcTMA^+$ is ionically associated with Cl^- in the bulk, as sulfonate latex is with H^+, because salt is absent in the bulk. When $FcTMA^+$ diffuses to the electrode, Cl- necessarily diffuses together in order to keep electric neutrality. Then the diffusional flux is twice (Fig. 4(A)) the flux in the presence of salt (Fig.4(B)).

[1] C.Wang, T Nagahashi, K.Aoki, J.Chen, J.Electroanal. Chem.,530(2002) 47.